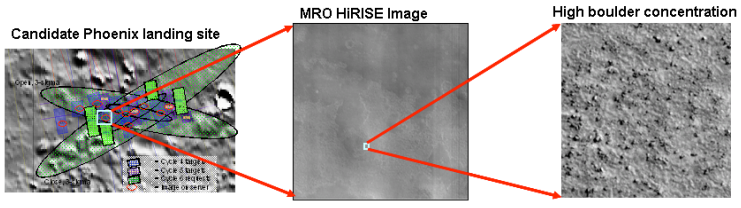
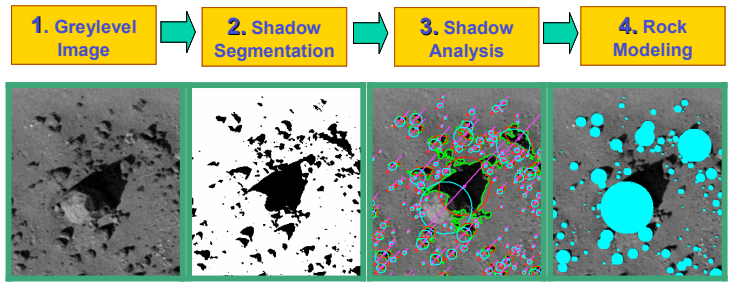
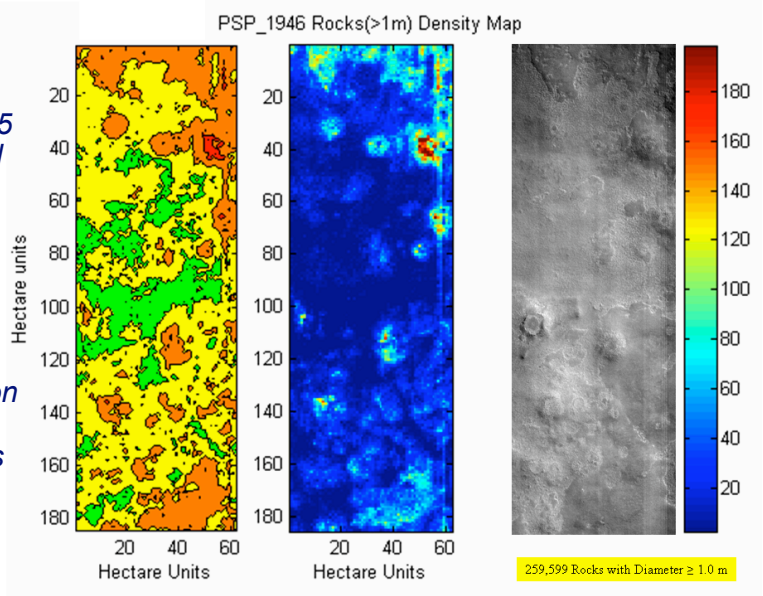
National Aeronautics and Space Administration

Mars Technology Highlight
Automatic Rock Detection and Mapping from HiRISE Imagery for Phoenix Landing Site Selection

- **Problem:** *Recent imaging by the MRO HiRISE Camera in support of Phoenix mission landing site selection activities has revealed high concentrations of boulders near the North Pole of Mars. These areas had previously been considered benign for spacecraft landing (top). 46 HiRISE images (over 36 gigabytes) have been collected over 3 potential landing sites, but only less than 0.01% of them have been analyzed by a time consuming manual process.*
- **Technology:** *Rocks cast shadows under a wide range of illumination conditions. These shadows not only indicate the presence of a 3D object but, with knowledge of the sun angles, their dimensions can be estimated as well. The rock detection algorithm consists of four steps (middle): 1) Obtaining grey level images, 2) shadow segmentation, 3) shadow analysis, and 4) rock modeling. This algorithm can detect individual adjacent rocks whose shadows may be merged, and the generates rock field statistics. This allows improved analyses not possible before, such as rock height-to-diameter ratio values, that affect determination of failure probability estimates and aid in the calibration of thermal imaging rock coverage estimates from much lower resolution sensors. The core algorithm of this system is based on an existing EDL real-time rock detection algorithm for landers developed under MTP Base Technology task.*
- **TRL-6 demonstration:** *The rock detection and mapping system has been tested recently against manually measured rocks counts for potential Phoenix landing site and multiple tests indicate close agreement. A tiled-process scheme developed under this work allows processing very large HiRISE images, e.g. image PSP_1946 which is 20048 by 60000 pixels (1.2 GB) or 6.2 by 18.6 km (115 km^2), in only a few minutes using a conventional laptop/desktop computer. A total of 259,599 boulders larger than one meter are detected in this image allowing straightforward construction of density and thematic maps (bottom). All HiRISE images inside of all 3 landing boxes have been processed and their corresponding rock distribution maps have been produced and provided to the project. Over 10 million individual rocks have been found and mapped in over 1500 km^2 area, which is unprecedented.*
- **Mission Impact:** *This technology is currently being used by the Phoenix mission for landing site selection. Without this system, it would be impossible to produce such rock hazard maps to meet the landing site certification review deadline. This technology is also applicable to Mars Science Laboratory (MSL) Mission as well as any future surface missions.*







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